OFFICE REPORT
NOT FOR PUBLICATION

AN ANALYSIS OF FIRE PROBLEMS IN THE LAKE STATES REGION AND A PROPOSED FIRE RESEARCH PROGRAM

by

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FOREST SERVICE
U. S. DEPARTMENT OF AGRICULTURE

St. Paul 1, Minnesota

RF-LS
RESEARCH PROGRAM
Problem Analysis

March 9, 1959

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FOREWORD

The following report is a brief review of the region's fire research needs at the present time. It is not a complete and detailed problem analysis of the regional fire problem. It is, rather, an attempt at a general summary statement that may serve as an effective set of guidelines to be used in establishing and setting in motion a significant program of fire research at the Lake States Station.

The report was written to be interpreted in context with Washington Office reflections on our situation. This has been expressed in part, "Current expenditures for fire protection and potential losses from fire through the Lake States territory clearly justify an active program of fire research ..... the first goal should be the establishment of a well-qualified team of two men to initiate a modest program of applied research projects and to plan and initiate a cooperative program. It will take some time to develop a full-scale cooperative program and more staffmen will be needed to carry it out. However, considerable advance planning needs to be done to enable orderly development."

The first two sections of this report will summarize the fire problem in the Lake States. Against a background of general information they will outline the present status of knowledge and note some of the existing gaps in basic information. Section III will list the more immediate sources of research effort available to contribute to work on fire problems of interest to the Lake States region. Section IV will outline a proposed 10-year program of fire research designed to meet the needs set forth in the other three sections.

SECTION I

BACKGROUND

Early Fire History

Probably no region in the United States shows the effect of wildfire upon its forest economy to the same extent as in the Lake States. Fires universally followed the cutting of the magnificant pine and hardwood forests throughout Michigan, Wisconsin, and Minnesota. Periodically, from the early logging of the post-Civil War period to the advent of organized fire protection in the second decade of the 20th century, numerous fires would merge to breed conflagrations for which the area is famous. The following nine fires burned over a total of 5 million acres and resulted in the loss of 2,500 lives:

Fire	Date	State	Acres burned
Peshtigo	1871	Wisconsin	1,280,000
Michigan	1871	Michigan	2,000,000
Thumb Fire	1881	Michigan	1,000,000
Comstock	1891	Wisconsin	64,000
Phillips	1894	Wisconsin	100,000
Hinckley	1894	Minnesota	160,000
Chisholm	1908	Minnesota	20,000
Baudette	1910	Minnesota	300,000
Cloquet	1918	Minnesota	250,000

Continuing on into the 1930's, scores of fires from 2,000 to 20,000 acres in size kept the average annual burn close to 1 million acres over the three Lake States. Other regions have had their "great fires," but none have suffered more often or more severely over the years than the Lake States.

Impact of Fire on Lake States Forests

The present forest in the Lake States is the product of widespread clear cutting followed by fire. Hot fires and repeated burns in the past are largely responsible for a continued growth deficit on some 26 million acres of poorly stocked young stands and nonstocked commercial forest land.

Conifers were reduced to a relatively minor component of the forest by past fires. Of the 5.8 million acres of original pine types in Minnesota alone, more than 1/2 million acres were deforested and 1-3/4 million acres were converted to aspen-scrub oak type largely through the result of wildfires following harvest of the pine.

On much of the Lake States acreage, pine is potentially the most valuable crop. At least 11 million acres, or more than one-fifth of the total commercial forest land in the Lake States, are ideal natural sites for pine. The vast expanses of pine forests that served as a base for the region's timber economy have been dissipated to less than one-third of their original acreage. The re-establishment of pine through natural regeneration or by planting is complicated by the fact that these young stands are especially hazardous fuel types in themselves. Plantations are relatively heavy investments in forest growth. Losses of second-growth pine, either natural or planted stands, therefore, have greater significance to the forest economy of the region than the area burned would indicate.

The effects of past fires do not accurately picture present effects of fire losses. On the other hand, they do illustrate the destructive results possible in this region without adequate protection. Although many of the conditions which made for past widespread losses to wildfire do not now exist, the forest values presently at stake demand nothing short of the best possible protection affordable.

Past and Present Trends

The history of fire control in the Lake States can be roughly divided into three periods of time (fig. 1):

(1) Dating from the estimates of the late 1800's through the recorded tally of the early 1930's, the annual burned area fluctuated widely, according to the nature of the seasons, from lows of 200,000 acres to highs in excess of 2 million acres. This period was characterized by heavy cutting throughout the three States and the almost total lack of organized protection effort. The average annual burn was close to 1 million acres.

(2) Through the middle and late 1930's, a drastic reduction in logging activity, coupled with the mass protective effort afforded by the C.C.C. program, resulted in a marked reduction in loss to wildfire. During that relatively short period of time the average burned area figure was pressed steadily downward to about one-tenth that of the earlier period.

(3) Since 1940 the annual loss has been maintained at the new average level of approximately 100,000 acres per year, with a marked downward trend going into the early 1950's. The record maintained through this period reflects the full maturing of the State fire control organizations and the lessening of fire risk resulting from more effective

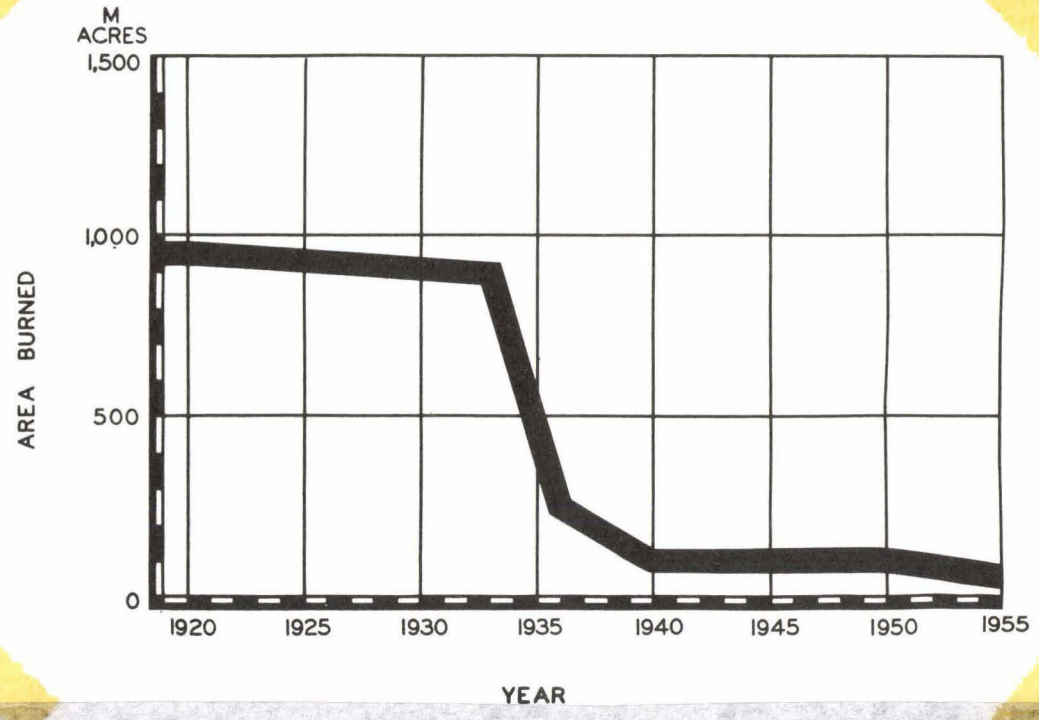


Figure 1.--Trend in area of forest land burned in the Lake States.

prevention efforts on a nationwide scale. Regionally, the total fire danger has been at an all-time minimum due to the low ebb of logging activity and subsequent scanty residue in the form of fire fuels.

Since 1953 the annual burned area has been on a steady overall increase. Because of future trends in risk factors and in fuel hazards (described below) this increase promises to carry on into the future. Particularly in the Lake States region, where the standard of protection from fire leads the rest of the country by a wide margin, fire protection has come about as far as practicable under present-day understanding and known methods. Future increases in fire risk and fuel hazards can result only in the magnification of the fire control problem throughout the Lake States.

Because of rapidly increasing forest values in the region, the fire control record must continue to improve. New lower levels of loss to fire must be attained. New higher standards of achievement must be the goal for adequate protection in the future.

Fire Hazard in the Years Ahead

The Lake States forest is a young forest and one in which widespread changes in species composition are taking place. Conversion of fuel types through planting also is having a significant impact on the type of forest we can anticipate protecting.

The volume of standing timber in the Lake States is now 20 percent greater than it was 25 years ago. Projections to 1975 show a continuing progressive buildup of timber volumes amounting to an estimated 40 percent of the present volume (fig. 2). As more of the poorly stocked and

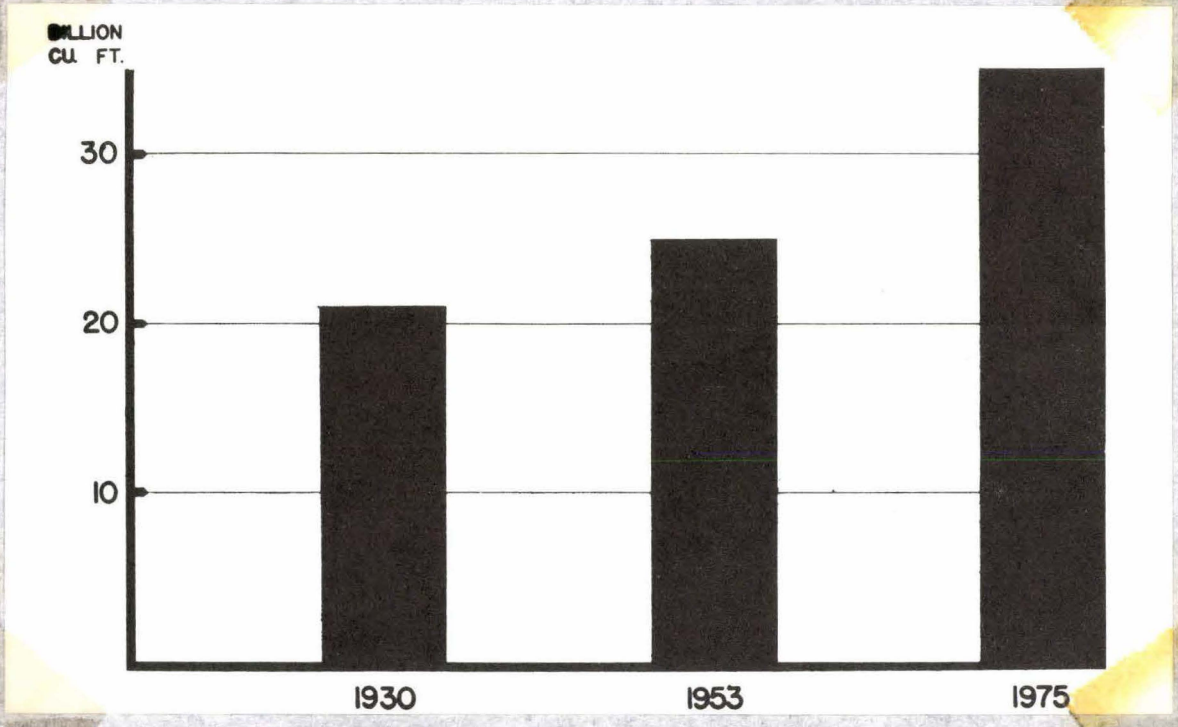


Figure 2.—Trend in volume of timber, 1930, 1953, and 1975.

nonstocked areas are rehabilitated into normal production, future timber volumes will eventually approach those that fed the conflagrations of early Lake States history.

With the rebuilding of timber resource will come increased utilization. Increased cutting of forest products will, by the last quarter of this century, begin to approach the volume of timber cut which set the stage for the earlier period of heavy timber losses from fire.

All of these forces act to increase fire hazard with the passage of time. The 16 million acres of pole-size timber and 20.4 million acres of seedlings and saplings contribute little at present to hazardous slash accumulations. Historic forest fire disasters in the Lake States occurred in the wake of peak logging activity during the late 1800's and early 1900's. The influence of increased cutting as present stands grow older will have a great bearing on fuels, microclimate, and increasing fire hazard of the future.

The 1½ million acres of established plantations are being added to at the rate of 100,000 acres per year. About 8½ million acres are classed as "plantable" by the Forest Survey. Additional acreage is converting to this condition each year. The present rate of planting is likely to increase as indicated by current trends, thus adding to the highly hazardous pine area which is associated with most of the region's larger fires (fig. 3).

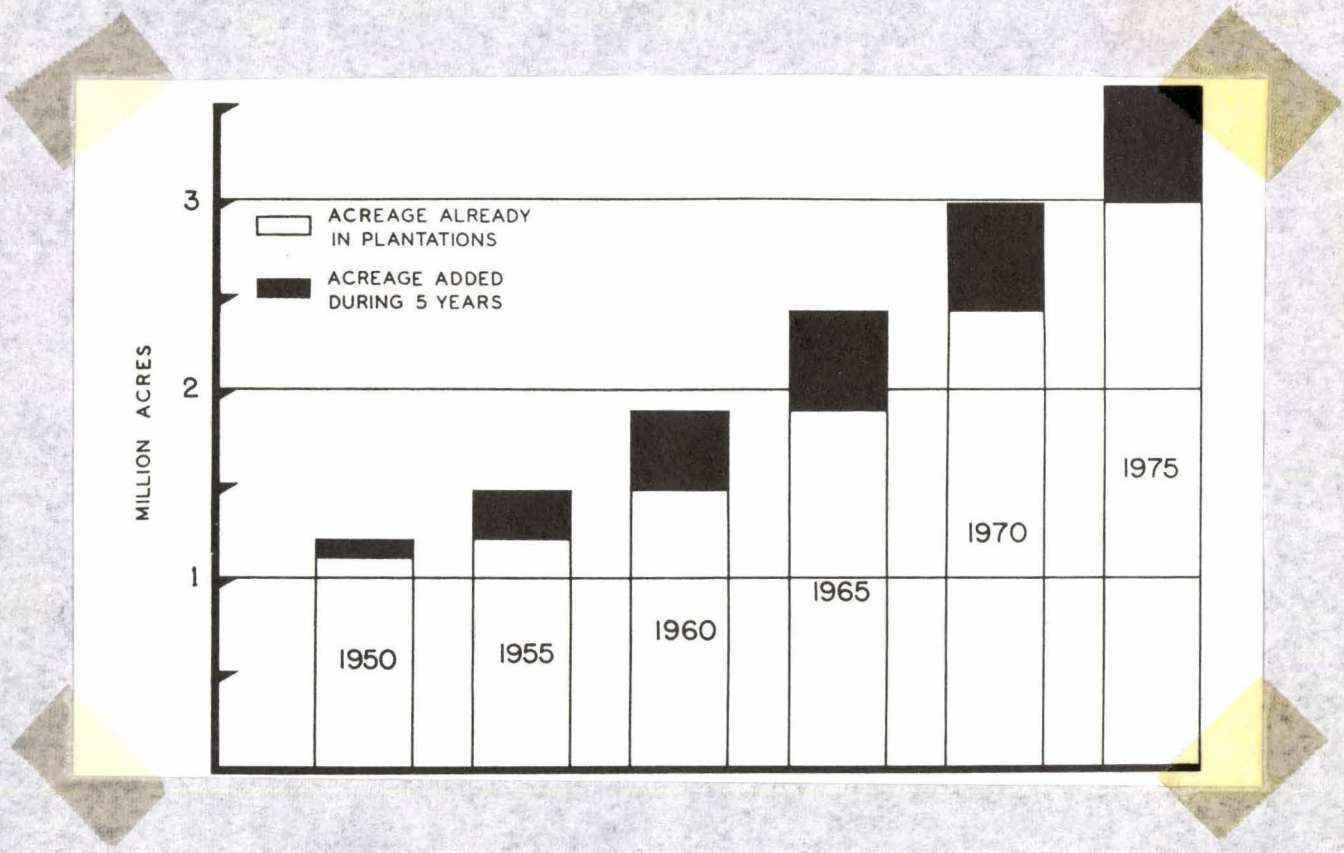


Figure 3.—Lake States forest plantations, 1950-1975.

Present and Future Fire Risk

The Lake States forests are heavily used for recreation. The abundance of lakes in close proximity to the great population centers of the Midwest are an ideal combination for this purpose. In addition, the area boasts an abundance and variety of game, which will continue to draw a large number of hunters annually. Without question the future level of use in forested areas will go up.

Increasing use of the forest will increase fire risk if the present relationship between public use and fire starts is maintained, as is likely. However, there will be related improvement in accessibility that will add to the effectiveness of control operations. The net result may be close to a standoff, with a slight increase in risk probable.

Fire Research

Research and development have played a vital part in the building of modern fire control systems throughout the United States. The Lake States Station has supported a fire research project since its establishment in 1923. To the present time, funds available for fire research have limited the program to that which could be carried out by one full-time researcher.

Much of the early work in fire research has been concentrated in cooperative effort with the State and Federal control agencies. During a period of growth and development these agencies felt their greatest need for research leading to information directly applicable to their immediate problems of organization, planning, and fire control methods.

Consequently, most fire research at the Lake States Station has been of an empirical nature. Making the most of analyzing and interpreting existing records, the program has served the immediate needs of fire control organizations in the developing of many aids; such as, a burning index meter, fuel classification schemes, damage tables, improved fireline equipment, methods of analyzing fire and weather records. The development of these tools has contributed in a large manner to the bringing about of effective fire control effort in the Lake States.

However, because of limited resources and the need to concentrate available effort, many aspects of fire control and fire use have received almost no attention in the Lake States region. Forest conditions and the associated kinds and extent of forest use have been changing. Even more rapid change can be anticipated in the near future. In addition a broad fund of experience has been built up and documented in the fire control record. Therefore, a fresh appraisal of research needs appears timely.

SECTION II

FIRE CONTROL IN THE LAKE STATES

The Present Fire Situation

Forty-three percent of the total land area in Michigan, Minnesota, and Wisconsin is classed as commercial forest land. The 55.2 million acres of forest land in these three States are 100 percent protected as compared to the national average of 93.2 percent. North Dakota forested land is approximately 92 percent protected at the present time. The protection load, on an area basis, is shown in the following table:

Total land area under protection

State	State and private	Federal
Minnesota	18,000,000	3,400,000
Michigan	17,120,000	2,730,000
Wisconsin	15,590,000	1,880,000
North Dakota*	116,000	1,144,000
Total	50,826,000	9,154,000

*Approximately 112,000 acres of State and private land in North Dakota classed as "needing protection" is at present unprotected.

The effectiveness of the control job being done in the area is reflected in the fact that the fire occurrence rate is only one-third that of the average over the protected forest land throughout the United States, and that in Michigan, Minnesota, and Wisconsin only 16 percent of the fires grow into the Class C or larger (over 10 acres) category as compared to the national average of 31 percent on protected areas during the same period (1951 to 1955).

However, the fact remains that during the average year the three States have a fire load of 2,000 to 4,000 fires that burn from 20,000 to 100,000 acres. Further, the State fire control organizations currently spend approximately $4½ million annually on fire protection. The seven national forests in the area spend a little less than $½ million in fire prevention, presuppression, and suppression activities. The annual fire control costs in the area total close to $5 million.

Average annual fire load (1951-55)

State	Number of fires	Acres burned
Minnesota	940	52,730
Michigan	1,357	8,690
Wisconsin	1,023	5,940
Total*	3,320	67,360

*Does not include North Dakota, for which information is incomplete.

In spite of a consistently lower rate of fire occurrence in Minnesota, that State has an annual burned acreage averaging from 2 to 5 times the combined loss in the remaining two States. Nearly one-third of Minnesota's fires grew to be larger than 10 acres in size as against about 10 percent in the more developed and populated States of Michigan and Wisconsin. The main reason for this difference between States appears to be the many extended areas of forest land in Minnesota with few, if any, year-round residents and no adequate roads or trails.

Forest land in Michigan is consistently exposed to a relatively high rate of fire occurrence. Large population centers near the southern part of this State account for heavy recreational use of the forested areas farther north with a resulting floodtide of debris burning and camper fires.

The normal fire season in the Lake States extends over the 214-day period between April 1 and October 31. Generally April and May are the worst months from the standpoint of number of fires and acres burned. The autumn fire season is concentrated in a short but acute period, generally in October. Late July and early August provide a source of hot-burning and hard-to-control fires which make the summer fire season a potential threat in the Lake States.

Over the three States approximately 70 percent of the fires and more than 80 percent of the burned acreage occur on the 40 to 50 days of high, very high, and extreme burning index ratings. It is during these comparatively few days that the 1 fire in 6 that exceeds 10 acres in size accounts for 86.5 percent of the burned acreage.

The occasional fire that escapes early detection and successful initial attack usually does so as a result of an unusual combination of fuel and weather. Crowning of the fire nearly always is involved. The chief source of hazard is the 4½ million acres of red pine and jack pine types which, with their annual slash accumulations, readily produce crown fires under severe weather conditions. Added to this are almost 1½ million acres of pine plantations which have the same hazardous fuel situation. Other high-hazard areas are the thousands of acres of marshland intermixed with upland forest which, with their highly inflammable grasses and sedges, provide a build-up area from which fires of high intensity can run into adjoining timber.

Most Lake States fires are man-caused. From 1951 to 1955, 87.8 percent of fires in the area were results of careless, thoughtless, or malicious use of fire by campers, smokers, debris burners, etc., in forested areas. The remaining 12.2 percent were caused by lightning and railroads.

In all three of the Lake States current information on fire control is unusually well documented and readily accessible on punch-cards. This assembled and tabulated information establishes a sound base for the effective fire control planning now evident in the area.

The present fire situation in the Lake States can be summarized in the following points:

1. The level of control is good in comparison with other regions, with Minnesota presenting a special problem because of lack of accessibility and Michigan being exposed to a high degree of risk.

2. Class C fires represent the major control problem.

3. Occurrence of Class C fires is closely associated with pine acreage and marsh margin.

4. Most fires and most burned acreage occur during fairly well-defined periods of time and during rather limited occasions of severe burning weather.

5. Public use of forested areas is the greatest cause of fire starts.

Present State of Knowledge of Fire Control

Research of the Station, together with that of the States, and experience of suppression agencies combines to provide information on which to base fire control organization. This can be conveniently discussed under the usual three sections into which fire control is partitioned.

Prevention

The knowledge basic to prevention effort is not regional in character. At least there is no special information that has been developed especially for conditions in the Lake States. Complete fire records in Michigan, Minnesota, and Wisconsin provide for analysis of fire starts by responsibility class, location, weather, fuel types, etc. This region's action program is limited to what the U. S. Forest Service stimulates through cooperation with the States and others.

Presuppression

The Lake States region is noted for the strong program of equipment development that the individual States have sponsored. Michigan has led, through its excellent equipment development center at Roscommon.

Wisconsin has had a similar program at its Tomahawk shop. Minnesota has been less active, but has produced equipment modifications of importance. Free exchange of ideas and developments in equipment design and use among the three States is promoted through the activities of Region 9 Fire Committee, which is sponsored by the U. S. Forest Service, Division of State and Private Forestry. On the whole, good equipment types are available and in use.

Plows and tanker units have been developed especially for Lake States conditions. Further modifications are in the nature of minor improvements. Handtools, pumper units, etc., have been designed, developed, tested, and have a performance record of several years.

Communication is by radio and will be improved as receivers and transmitters are improved. Of chief concern at the present time are the future possibilities of costly revamping of radio communication nets made necessary by occasional shifting of assigned frequency bands.

Danger rating with the Lake States burning index meter is satisfactory for normal burning conditions but shares the same deficiencies as other meters in not adequately reflecting extreme conditions associated with drought.

Detection needs have been adequately analyzed for the conventional tower grid system. However, costs are outmoding this system and alternative aerial methods have not been systematically investigated. Regular detection patterns are flown on the Superior National Forest and use of airplanes for occasional detection and for scouting is common in Wisconsin and in Michigan.

Firebreak systems are used in some areas of the Lake States but it is known that the conventional plowed line is of little assistance in stopping crown fires or those burning under severe weather conditions. Due to costs involved, most firebreak maintenance at the present time is limited to locations where heavy risks of fire starts exist. Remotely located firebreaks are now maintained chiefly to make them usable as access trails for suppression forces.

Relationships of fuel complexes to difficulty of control are well known in general terms as a result of experience. More detailed information on amounts and rate of buildup of red pine plantation fuels in relation to site, stocking, and age has been gathered recently and is now being analyzed.

Suppression

Vagaries of the Lake States weather have long been recognized as the most important factor affecting success of suppression efforts. Yet aside from such investigation as was necessary for development of the burning index meter, little is known of weather relationships.

Getting fires under control while they are small is the key to effective control action. Suppression costs and damage figures multiply rapidly with an increase in fire size. The larger the fire is allowed to develop before being brought under control, the greater is the probability of its developing into a costly "project" fire. Proper balance between speed and strength of initial attack is being worked out largely by trial and error. Dispatching guides have been devised based on experience, but early successful control of new fire starts is still problematical in the Lake States.

Areas of Needed Investigation in Relation to Fire Control

Prevention

The problem of preventing fire starts in the Lake States is similar to that in several other regions. Also, action programs in any of the States are the product of coordinated efforts affecting fire prevention nationally. The problems of prevention therefore are of national or super-regional rather than regional character. Continuing analysis of fire prevention needs and practices is needed to make Lake States programs more effective but the problem should be attacked on a broader base than in one region. Although much is known as to "who" starts the fires, much remains to be known as to the "why" or the "whereby," either of which is basic to the problem of precise prevention efforts.

Presuppression

Because the larger fire and the critical weather situation cause most of the region's acreage loss, development of better hazard prediction mechanisms is needed. Essentially this means incorporating a drought factor in the present burning index meter. A project is now under way to study the various regional meters and work out a procedure that will have application nationally or at least over a large section of the country--perhaps one for the East and one for the West. The problem of long-continued buildup of critical burning conditions is to be included in this general project. Studies also are needed to link seasonal or climatic factors with the flammability of green fuels, particularly pine foliage, so that means of predicting "project" fire probabilities becomes feasible.

Maintenance of adequate detection is a growing problem in the Lake States. Tower systems are becoming more and more difficult to justify and means of replacing or supplementing them have not been worked out. Aerial detection probably should be expanded to fill the gap. Methods are needed for evaluating the problem and devising the most effective way of solving it.

The special problem in fire control attached to expansion of planted acreage naturally suggests the possible use of firebreaks developed as part of the planting pattern. Conventional plowed breaks are ineffective in stopping fires during critical fire danger but can be useful in cutting acreage losses and as initial lines to work from. They are expensive to maintain, but are used in a number of areas at the present time. Cheaper and more effective maintenance through use of chemicals should be explored. The requirements and specifications for effective firebreaks need to be worked out. Proper design and location of firebreaks depend on a variety of factors, all of which are subject to logical analysis and which possibly have not, in the past, been thoroughly taken into consideration. Vegetated firebreaks or other types of alternative methods of breaking up planted areas need to be studied.

Information on fuels, their classification and relationship to difficulty of control, is meager in general but especially so for the important pine acreage. Means must be developed by which fuels may be classified and calibrated in terms that have bearing on fire suppression techniques. The many and varied cover types in the Lake States present a unique problem in gearing fire control techniques to existing fuel conditions. A preliminary study has been made in red pine plantations. This needs to be supplemented with additional site, age, density, and topographic

relationships for natural and planted stands of all the pine species. Study of the ignition and behavior of fires in relation to these fuels is a necessary part of this investigation.

Suppression

Weather is the most important factor bearing on fire control in the Lake States. In a region noted for violent fluctuation in weather conditions and for extremes, some understanding of weather patterns is essential. Land features, especially the presence of Lake Superior and Lake Michigan, condition the response to moving air masses at the local level throughout the three States. The exact nature and extent of these localized effects need further study and definition. At present most of what is known is based on experience. However, this fund of information probably is being reduced instead of augmented as time passes. This is due to the replacement of veteran fire control personnel by younger men who have had less opportunity to appraise fire action under extreme conditions.

A factual basis for understanding possible weather shifts in the dynamic fire situation is badly needed. Some work on precipitation has been done by the Station. This needs to be strengthened and supplemented with data on other factors of weather.

Studies must be designed to yield much-needed clues to the proper balance between speed and strength of initial attack in the efforts to assure quick control of newly started fires.

Fire Use

Very little prescribed burning is done in the Lake States. A token amount of slash reduction is done by broadcast burning on the Superior National Forest. Fire is used for game habitat improvement on a few areas

in Wisconsin and has been used for the same purpose in Michigan, but not in the last few years. Essentially no use is made of fire for silvicultural purposes.

Fires were important in maintaining the dominance of pine in the virgin forest. Regeneration of jack pine obviously was closely related to periodic fire. The relationship with red pine is not so clear cut but has been substantiated by investigation. Regeneration of these pine species is dependent on control of competing vegetation and improvement of the seedbed by artificial means. Fire is a possible agent that might be more economical than the mechanical or chemical methods now recommended.

The favorable effect that burning has on big-game habitat is more easily recognized. However, there are problems in application and the best browse species may not always be increased in productivity by fire. Game managers also point out the difficulty of treating large enough areas to have any significant effect on game populations. The joint effects of fire on game habitat and on timber have not been appraised except as separate observations on different areas. Timber cutting has significant effect on productivity of forest areas for game. Any fire treatment for silvicultural purposes likewise will have game habitat aspects that should be evaluated.

The effects of fire on forest soils is fairly well defined in general terms. More is yet to be learned of the relationships involved when dealing with specific soil types, forest covers, and fire characteristics.

Needed research on fire use falls into two categories or stages. First is the quantitative determination of fire characteristics associated with given fuel complexes, burning conditions, and types of fire. Second is the determination of effects on vegetation and on seedbeds attributable to various fire characteristics.

SECTION III

FOREST FIRE RESEARCH PROGRAMS AND FACILITIES

National Fire Research Program

Nationwide, fire research activities have been expanded roughly five times in the past 5 years. Nearly all of the increase has been centered in the South and in the West. However, fire research activities are carried on at all nine of the Forest Experiment Stations.

Notable in this programming of strengthened effort is the establishment of three fire laboratories. Two of these are in the western regions and the other in the South. The facilities and personnel of these fire laboratories will be available for the attacking of many key problem areas which are of common interest to fire researchers everywhere. From them will come much fundamental knowledge, an understanding of which will establish principles for sound practice of fire control and effective use of fire. This flow of new knowledge demands increased effort in the northern region aimed at adapting and applying data to northern forest conditions if we are to keep pace with the "new look" in forest fire management.

In addition, we in the North have fire control problems unique to our forest types and economy. These call for an expanded program of research effort centered on the problem areas peculiar to our own conditions.

Fire Research in the North

Three forest experiment stations serve the northern regions. All three maintain a fire research program at the present time.

Central States Forest Experiment Station.--The newest of these is at the Central States Forest Experiment Station, where since World War II one man has been assigned to fire problems over the five-state Central States area. Work at this Station in the past has been concerned with effects of forest-land burning upon grazing values of the region. Some work on local wind and humidity patterns has been done with reference to Missouri weather phenomena. Fuel studies done at the Central States Station have dealt largely with hardwood leaf litter, distinctive of the oak types of that area.

Northeastern Forest Experiment Station.--Much pioneer work in fire research has been done in the past at the Northeastern Forest Experiment Station. Early advances in the technique of evaluating fire danger came directly from studies relating weather phenomena with fuel moisture which were done at this station. Reactivation of the Northeastern Station's interrupted fire program was accomplished during the past 3 years. Since that time one full-time research forester has been assigned, and at present is completing problem analyses on a state-by-state basis throughout this region.

Lake States Forest Experiment Station.--Fire research at the Lake States Station has been a responsibility of the Division of Forest Management Research. The St. Paul office maintains a position of project leader and specialist, attached to the Division and assigned primary duties within the area of fire investigations. In this capacity the fire research position (1) participates in planning for studies at field centers, (2) offers assistance as a subject-matter specialist, and (3) fills in areas of research with special studies pertaining to fire in all of its aspects.

Research in fire effects will account for a continuing large and important share of planned work at the Station. Such work will be directed toward the answering of many questions pertaining to fire damage and use of fire in forest-land management. Of the almost limitless number of project possibilities in the area of fire effects, many, if not all, are ideally suited to the attention of individual research centers within the framework of Forest Management Research.

Universities.--Although there are four accredited schools of forestry within the Lake States, no one of these is equipped with facilities and personnel needed for a comprehensive program of fire research. At the present time it seems unlikely that any of the existing schools of forestry in the area will be willing, in the foreseeable future, to assume leadership in this much-needed field. None are at present doing more than occasional piecemeal studies pertaining to fire. All of the schools, however, are in position to make valuable contributions to a cooperative program which takes full advantage of the existing personnel and facilities in the area.

Quetico-Superior Wilderness Research Center.--Vegetative succession on burned areas is being studied by one man as a part of his widely diversified activities. This work is likely to continue at about the same level with emphasis shifting to silvicultural applications.

Roscommon Station.--The State of Michigan maintains an equipment development station at Roscommon. Here, complete facilities exist for design, manufacture, and testing of forest fire equipment of all sorts. A strong program of cooperative effort between the Roscommon Station and the Lake States Forest Experiment Station once formed an important share of early fire research effort in the region. Roscommon is well situated for centralization and strengthening of a regional equipment testing and evaluation program.

Cooperation Available

Fire research activity in the Lake States has been a cooperative venture from the beginning. The States have supplied records and have field-tested practical application of research results. Direct cooperation at the Roscommon Station was a feature of the program at one time. This relationship between the fire control agencies and research is expected to continue. In addition the land-managing agencies are interested in possible use of fire and are ready to aid in prescribed burning experimentation.

A common type of cooperation in the past has been for the control agencies to turn over to the Station the records and such assistance as was necessary to work out a suitable answer to an administrative problem. This type of work may be included in the future program but it will have much less emphasis. Of chief interest along this line are organizational and operational problem areas on which available records may lend themselves to analysis through newly developed Operations Research techniques. The progressive development of new fire control equipment and methods, along with ever-changing risk factors and fuel hazards, demands constant and effective use of available data in the administration of fire control organizations.

The wildlife habitat aspects of prescribed burning will call for cooperative studies with wildlife biologists. Exploratory work of this character is now under way. Future expansion will depend on how favorably the State conservation departments view this type of investigation and on availability of Federal funds for habitat research.

The many excellent departmental facilities of the universities and colleges in Minnesota, Michigan, and Wisconsin (other than forestry) have been virtually untapped in past fire research programming. Many problem areas within the scope of fire research programming involve techniques which immediately suggest cooperative effort with nonforestry oriented groups. Botany departments and engineering schools offer much potential in the manner of available cooperation on specialized studies pertaining to fire problems.

SECTION IV

PROPOSED PROGRAM OF FIRE RESEARCH

Summary of Factors Bearing on Program Emphasis

1. Class C fires are the major control problem.
2. Pine acreage and marsh margin are closely associated with occurrence of Class C fires.
3. Plantations are a special phase of the general pine protection problem.
4. Pine acreage is especially important to the economy of the region at present and is expected to increase in importance in the future.
5. Fuels in the hazardous pine types and as related to prescribed burning are not adequately classified.
6. Characteristics of fire as related to fuels and burning conditions are incompletely known.
7. Information on weather as related to the dynamic fire situation and to the use of fire is very limited.
8. The present detection framework is approaching obsolescence and adjustments must be made to meet this situation.
9. Rapidly changing values associated with forest land demand continuous re-examination of fire control standards and objectives.
10. Changing patterns of fire starts and fuel types, along with advances in fire control equipment and techniques, call for constant re-evaluation of organizational and operational planning.
11. Possible use of fire in regeneration of conifers and in wildlife habitat improvement is poorly defined.

Organization

Fire Research at the Lake States Station will continue as a Section under the Division of Forest Management Research. Planning and staffing will be concentrated at the Station headquarters in St. Paul. Under this arrangement maximum cooperation can be developed with the individual research centers and the State fire control organizations.

Program

The following is an outline of a 10-year program of fire research at two levels of effort. The lower level is with present financing. Four full-time researchers, with an annual allotment of $75,000, has been set as a goal for the proposed expanded program.* Operation at the expanded level of staffing and financing would make possible the attaining of cooperative assistance and funds, a conservative value estimate of which is made at $15,000.

Item	Present program	Proposed expanded program
Staff	1	4
Cooperation Funds and Assistance	None	$ 15,000
Federal funds	$ 8,800	75,000
Major projects	1. Fuels	1. Fuels
	2. Effects	2. Effects
		3. Weather
		4. Presuppression - hazard reduction
		5. Fire control methods

* See page 34 for proposed organization and staff.

Description of Major Projects

Fuels

Qualitative study of fuels will be aimed at eventual classification of specific fuels in terms which bear upon their relation to fire behavior characteristics under various burning conditions. Early efforts will be centered on green fuels, particularly pine foliage.

Quantitative studies, also, will aim at full description of the many and varied fuel complexes experienced in Lake States forest cover types. Initial emphasis will be on pine types and, in particular, plantations.

Analysis of fire behavior in Lake States fuel classes will be correlated with techniques and measurements developed at the fire laboratories.

Planning for future work in forest fuel problems includes the following items:

1. A major project will be undertaken to determine seasonal or cyclical changes in red pine foliage flammability. Included are:
   a. Moisture relationships in the foliage and correlated with moisture available to the roots.
   b. Amount of crude fat in relation to total weight.
   c. Effect of age of needles.
2. Other projects in this category that may be developed with additional resources are:
   a. Fuel classification.
   b. Rates of spread.
   c. Calorimetric and combustion rates studies in forest fuels.
   d. Seasonal fuel factors.

Effects

Work with the research centers will be developed around the effects of fire as regards fire use in forest-land management.

1. At the Station level, early project emphasis will be on relating specific fire effects to fire characteristics in terms of temperature distribution and duration. The regional fire laboratories may be able to assist in developing basic measures of fire characteristics that are applicable to Lake States conditions. By the spring fire season of 1960 measures of fire intensity will be developed for use in studies of fire effects.
2. Other research on fire effects at the present program level will be limited to what the research centers are able to undertake. Following are some of the studies that may be included:
   a. Direct effects of fire on the physical and chemical properties of specific soil types.
   b. Effects of heat on vegetative and reproductive processes of plants.
   c. Thermal characteristics of tree barks.
   d. Ecological effects of fire in Lake States forest cover types.
   e. Indirect economic effects of fire (forest credit, insurance, etc.).

Presuppression - Hazard Reduction

In light of what is now known about fire starts and fire spread in the Lake States, there is much to be explored in the way of fuel manipulation to minimize total fire danger.

A continuing project in presuppression - hazard reduction would have as its goal the integration of certain fire control aspects into overall forest management. Building fire control into everyday forest practices would be based upon detailed knowledge of such matters as: effects of silvicultural practices on fire fuels and microclimate, criteria for adequate design and layout of firebreaks, impact of multiple-use aspects on fire control problems.

Specific study areas of particular interest in the Lake States are:

Effects of silvicultural treatments on fuels and microclimate in pine stands.

Firebreak design and location in planted areas.

Firebreak construction and maintenance.

Presuppression treatment of forest fuels (chemical, mechanical, fire, etc.)

Weather

Weather research in the Lake States will be confined to detailed study of local responses to regional weather patterns. The vagaries of a continental climate are complicated in this area by the fact that several "weather centers" vie with each other in furnishing the area its climate. Continental and maritime polar air masses continually meet with each other, or with maritime tropical air, over the Lake States and upper Central States regions. Drying conditions and wind profiles often change radically within a few hours time in response to weather dynamics which at present are not well defined in terms meaningful to fire control planning.

Cooperative effort with the U. S. Weather Bureau, which maintains a fire weather forecaster in Chicago, will give substance to efforts in this project.

Fire Control Methods

Many problems in fire control lend themselves very well to analysis through Operations Research techniques. The project at the Lake States Station will seize every opportunity to take advantage of O. R. methodology in the solution of organizational and operational problems. Most effort will be in cooperation with Lake States control agencies.

Of particular importance to the Lake States region will be research effort within the following study areas:

Aerial detection evaluation and standardization.

Optimum balance between ground detection and aerial detection.

Speed versus strength in initial attack.

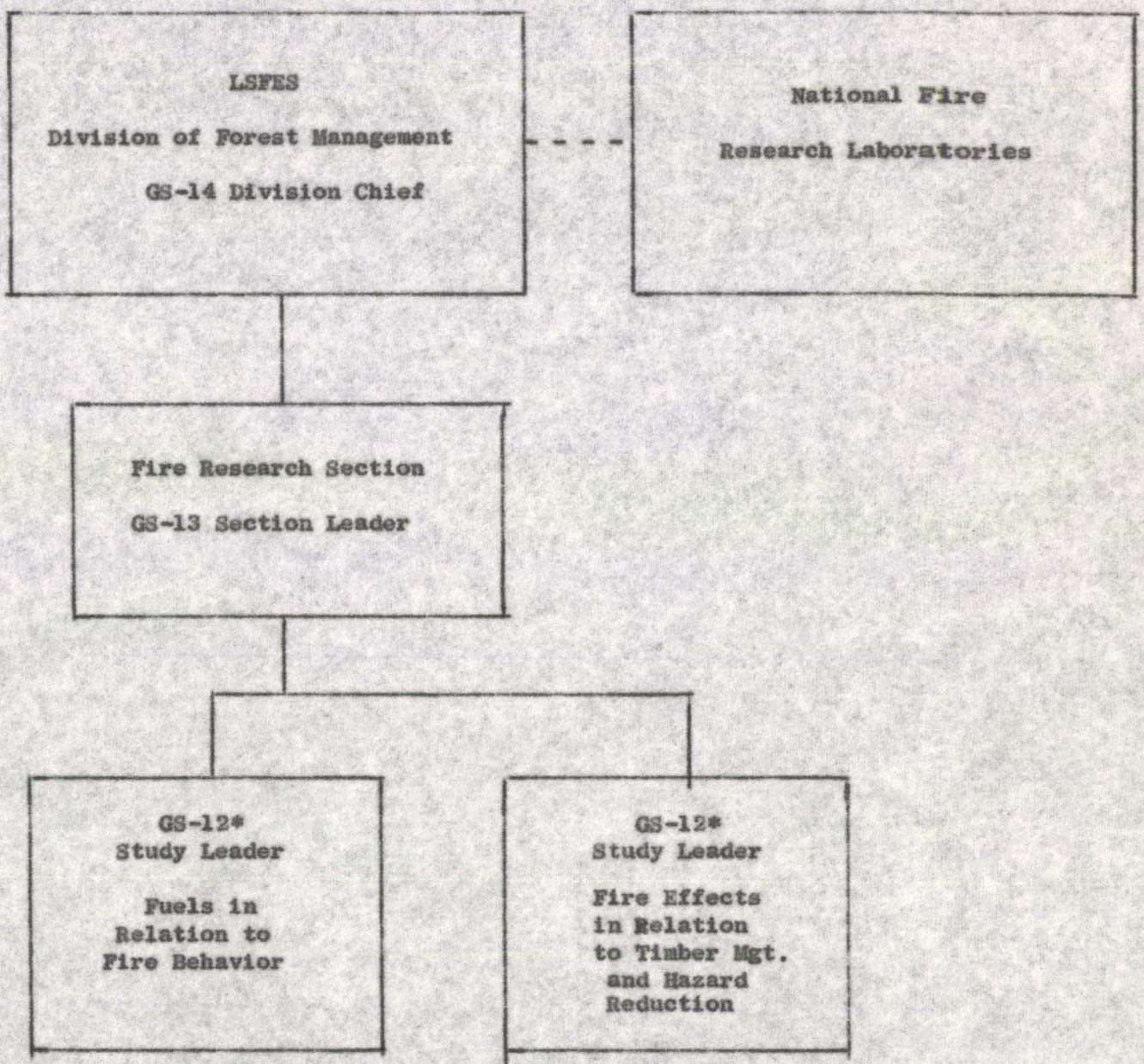
Fire-fighting methods on project fires.

Measuring suppression output of men and machines.

Inventories and caching of fire equipment.

Le May questions tower obsolescence except as manning problem.

Proposed Organization for Expanded Fire Research Program in the Lake States Region



*Each study leader to be assisted by GS-9 positions financed in part by cooperative funds.